CLAIMS

WHAT IS CLAIMED IS:

1. An interferometric inspection system for inspecting a semiconductor sample, the system comprising:

at least one illumination source to generate an illumination beam;

an interferometric microscope module for splitting the illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a reference mirror, and directing the test beam reflected from the sample and the reference beam reflected from the mirror to generate an interference image;

an image sensor for receiving the interference image generated by the inteferometric microscope module; and

an alignment module located in the optical path between the interferometric microscope module and the image sensor for adjusting at least one of the orientation and position of the interference image relative to the image sensor.

2. The interferometric inspection system of claim 1, wherein the interference image signal is further processed by a processing module configured to generate complex field information corresponding to the sample.

3. The interferometric inspection system of claim 1, wherein the adjustment of the interference image relative to the image sensor occurs in response to an interference image signal derived from the image sensor.

4. The interferometric inspection system of claim 1, wherein the alignment module comprises at least one folding mirror.

5. The interferometric inspection system of claim 4, wherein the generated complex field information corresponding to the sample corresponds to one of spatial

fringe analysis and temporal fringe analysis performed on the fringes of the interference image signal.

6. The interferometric inspection system of claim 4, wherein the processing module is further configured to evaluate fringe modulation present in the interference image signal to determine the presence of a defect in the semiconductor sample.

7. The interferometric inspection system of claim 2, wherein the processing module is further configured to compare the interference image signal with a stored image signal to determine the misalignment between the interference image and the stored images and to generate an alignment feedback signal based on such determined misalignment.

8. The interferometric inspection system of claim 1, further comprising an adjustable magnification module located in the optical path between the interferometric microscope module and the image sensor for adjusting the size of the interference image onto the image sensor

9. The interferometric inspection system of claim 1, wherein the reference mirror is located in a reference module for generating the reflected reference beam for interferometric inspection for defects.

10. The interferometric inspection system of claim 1, wherein the reference module is configured to generate complex field information by one of phase shifting and spatial fringe techniques.

11. An interferometric inspection system for inspecting a semiconductor sample, the system comprising:

at least one illumination source to generate an illumination beam;

an interferometric microscope module for splitting the illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a reference mirror, and directing the test beam reflected from the sample and the reference beam reflected from the mirror to generate an interference image;

an image sensor for receiving the interference image generated by the inteferometric microscope module; and

an adjustable magnification module located in the optical path between the interferometric microscope module and the image sensor for adjusting the size of the interference image onto the image sensor.

12. The interferometric inspection system of claim 11, wherein the image sensor comprises a plurality of pixels and the adjustable magnification module is configurable to adjust the size of a feature in the image to correspond to an integral number of pixels.

13. The interferometric inspection system of claim 11, wherein the adjustable magnification module provides a variable focal length system between the interferometric module and the image sensor.

14. A interferometric inspection system for inspecting a semiconductor sample, the system comprising:

at least one illumination source for generating a coherent illumination beam and an incoherent illumination beam;

an interferometric microscope module configured to split the coherent illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a first reference mirror, and to direct the test beam reflected from the sample and the reference beam reflected from the first reference mirror to generate an interference image and to split the incoherent beam into a test beam directed to the semiconductor sample and a reference beam towards the first reference mirror, and to generate an interference image for topographic measurement, wherein the topographic measurement comprises determining an image of a sample at a selected axial position of the test beam axis relative to the surface of the sample;

a switching mechanism for switching the operation of the inspection system between interferometric inspection and topographic measurement; and

an image sensor for acquiring the interference image from the inteferometric microscope module and generating an interference image signal.

15. The interferometric inspection system of claim 14, wherein the at least one illumination source is a coherent source which generates an incoherent illumination beam by transmitting a coherent illumination beam through a speckel buster.

16. The interferometric inspection system of claim 14, wherein the at least one illumination source is a coherent source and an incoherent source.

17. The interferometric inspection system of claim 14, further comprising a dichroic mirror to separate the illumination for the topographic measurement from the illumination for the interferometric measurement.

18. The interferometric inspection system of claim 14, wherein the reference mirror is located in a reference module for generating the reflected reference beam for interferometric inspection.

19. The interferometric inspection system of claim 14, wherein the reference module is configured to generate complex field information by one of phase shifting and spatial fringe techniques.

21. An interferometric inspection system for inspecting semiconductor samples, the system comprising:

at least one illumination source to generate an illumination beam;

an interferometric microscope module for splitting the illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a reference mirror, and combining into a combined beam the test beam reflected from the sample and the reference beam reflected from the reference mirror, the combined beam forming an interference image, wherein the reference mirror is tilted at a non-normal angle with respect to the incident reference beam to generate fringes in the interference image;

an image sensor for receiving the interference image from the inteferometric microscope module and generating an interference image signal from the interference image;

an alignment mechanism located in the optical path between the interferometric microscope module and the image sensor to provide adjustment between the interference image and the image sensor; and

a processing module configured to generate complex field information corresponding to the semiconductor sample from the interference image signal.

22. The interferometric inspection system of claim 21, wherein the processing module is configured to generate complex field information corresponding to the sample from one of spatial fringe analysis and temporal fringe analysis performed on the fringes of the interference image signal.

23. The interferometric inspection system of claim 21, wherein the processing module is further configured to evaluate fringe modulation present in the interference image signal to determine the presence of a defect in the semiconductor sample.

24. The interferometric inspection system of claim 23, wherein the processing module is configured to evaluate fringe modulation present in the interference image signal to determine the presence of depolarization or a change in materiel reflectivity in the inspection beam reflected from the sample.

25. The interferometric inspection system of claim 22 wherein the reference mirror is moveable along the axis of the incident reference beam and the processing module is configured to generate complex field information from temporal fringe analysis performed on the fringes of the interference image signal.

26. The interferometric inspection system of claim 25, wherein the processing module is further configured to acquire and store interference images corresponding to the semiconductor sample generated from at least 3 different axial positions of the reference mirror and to generate complex field information corresponding to the

semiconductor sample from temporal fringe analysis of the at least 3 interference images.

27. The interferometric inspection system of claim 21 wherein the inspection system is configured to acquire two or more images of a selected portion of the semiconductor sample, each image corresponding to a different axial plane.

28. The interferometric inspection system of claim 21 wherein the processing module is configured to perform fringe modulation analysis of the interference image signal.

29. The interferometric inspection system of claim 21 wherein the processing module is further configured to identify and compare a location of a feature in the interference image with a location of a similar feature in a stored image to determine the misalignment between the interference image and the stored images and to generate an alignment signal based on such determined misalignment and wherein the alignment mechanism is configured to provide adjustment in response to the alignment signal.

30. The interferometric inspection system of claim 21 wherein the adjustment provided is one of translation and rotation of the image in the plane of the surface of the image sensor.

31. The interferometric inspection system of claim 21 wherein the alignment mechanism comprises at least one folding mirror.

32. The interferometric inspection system of claim 22 wherein the processing module is further configured to compare the reconstructed complex field information for the sample with complex field information for a stored image signal to generate a resultant image signal, wherein the resultant image signal is used to identify defects in the semiconductor sample.

33. The interferometric inspection system of claim 32 wherein the processing module is further configured to process the resultant image signal to more easily distinguish sample defects from pattern noise.

34. The interferometric inspection system of claim 33 wherein the pattern noise comprises at least one of process variations and alignment mismatches.

35. The interferometric inspection system of claim 33 wherein the processing of the resultant image signal comprises one of applying a Fourier transform, correlation analysis, and low pass filtering.

36. The interferometric inspection system of claim 33 wherein the processing module is further configured to identify defects in the resultant image signal by comparing the pattern of the defect with known defect patterns stored in a memory associated with the processing module.

37. The interferometric inspection system of claim 21, further comprising an adjustable magnification module to provide fine adjustment of the size of the interference image onto the image sensor.

38. The interferometric inspection system of claim 37, wherein the processing module is further configured to identify and compare a first portion of the interference image corresponding to a first portion of the semiconductor sample with a second portion of the interference image corresponding to a second portion of the semiconductor sample.

39. An interferometric inspection system for inspecting semiconductor samples, the system comprising:

at least one illumination source to generate an illumination beam;

an interferometric microscope module for splitting the illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a reference mirror, and combining into a combined beam the test beam reflected from

the sample and the reference beam reflected from the reference mirror, the combined beam forming an interference image;

a switching mechanism for switching the operation of the inspection system between interferometric measurement and topographic measurement.

an image sensor for acquiring the interference image from the inteferometric microscope module and generating an interference image signal; and

a processing module configured to generate from the interference image signal one of topographic measurements and complex field information corresponding to the semiconductor sample.

40. The interferometric inspection system of claim 39, wherein the at least one illumination source comprises a coherent source and a broadband source.

41. The interferometric inspection system of claim 39, wherein the switching mechanism comprises a dichroic surface located in the optical path between the interferometric microscope module and the reference mirror for reflecting a portion of the incident reference beam back along the path of the incident reference beam to the interferometric microscope module to perform the topographic measurement.

42. The interferometric inspection system of claim 39, wherein the switching mechanism comprises a shutter located between the at least one illumination source and the interferometric microscope module.

43. An interferometric inspection system for inspecting semiconductor samples, the system comprising:

at least one illumination source to generate an illumination beam;

an interferometric microscope module for splitting the illumination beam into a test beam directed to the semiconductor sample and a reference beam towards a reference mirror, and combining into a combined beam the test beam reflected from

the sample and the reference beam reflected from the reference mirror, the combined beam used to generate an interference image;

a switching mechanism for switching the operation of the inspection system between interferometric measurement and topographic measurement, wherein the topographic measurement comprises determining an image of a sample at a selected axial position of the test beam axis relative to the surface of the sample;

an adjustable magnification module to provide fine adjustment of the size of the interference image onto the image sensor;

an alignment mechanism located in the optical path between the interferometric microscope module and the image sensor to provide adjustment between the interference image and the image sensor by compare a location of a feature in the interference image with a location of a similar feature in a stored image to generate an alignment signal to determine the misalignment between the interference image and the stored images;

an image sensor for acquiring the interference image from the inteferometric microscope module and generating an interference image signal; and

a processing module configured to generate from the interference image signal one of topographic measurements and complex field information corresponding to the semiconductor sample, wherein the complex field information corresponding to the sample is generated from one of spatial fringe analysis and temporal fringe analysis performed on the fringes of the interference image signal.

44. A method for inspecting a wafer using interferometric techniques, the method comprising:

a) combining a test wave reflected from a first portion of a wafer and a reference wave reflected from a reference mirror to produce on an image sensor an interference optical image,

b) reconstructing complex field information for the first portion from the interference optical image;

c) generating a first signal representation of the first portion of the wafer using reconstructed complex field information, and

d) comparing the first signal representation to a second signal representation of a wafer to generate a resultant signal representation, wherein the resultant signal representation is used to identify defects in the first portion of the wafer.

45. The method for inspecting a wafer recited in claim 44, wherein the first signal representation and the second signal representation correspond to the same wafer.

46. The method for inspecting a wafer recited in claim 44, wherein the first signal representation corresponds to a design database file.

47. The method for inspecting a wafer recited in claim 44, wherein the first and second signal representations correspond to different wafers.

48. The method recited in claim 24 wherein reconstructing complex field information for the wafer comprises performing one of spatial fringe analysis and temporal fringe analysis on the fringes of the interference image.

49. The method recited in claim 44 wherein the complex field information reconstructed represents at least one of phase and amplitude information corresponding to the wafer.

50. The method recited in claim 44 further comprising:

processing the resultant image signal to more easily distinguish sample defects from pattern noise.

51. The method recited in claim 50 wherein the pattern noise comprises at least one of process variations and alignment mismatches.

52. The method recited in claim 50 wherein the processing of the resultant image signal comprises one of applying a Fourier transform, correlation analysis, and low pass filtering.

53. The method recited in claim 44 further comprising identifying defects in the resultant image signal by comparing the pattern of the defect with known defect patterns stored in a memory associated with the processing module.

54. The method recited in claim 44 further comprising adjusting the magnification of the interference image in fine increments to align portions of the interference image corresponding to similar features from 2 different portions of the wafer with pixel locations on the image sensor.

55. The method recited in claim 44 further comprising:

identifying and comparing a feature in the interference image with a location of a similar feature in a stored image to determine the misalignment between the interference image and the stored image and to generate an alignment signal.

56. The method recited in claim 55 further comprising adjusting the interference image with respect to the image sensor in response to the alignment signal.

57. The method recited in claim 55 wherein adjusting the interference image comprises one of translation and rotation of the image in the plane of the image sensor.

58. The method recited in claim 55 wherein adjusting the interference image comprises movement of at least one folding mirror in the optical path between the interferometric microscope module objective lens and the image sensor.